September 19, 2016

Flathead National Forest
Attention: Forest Plan Revision
650 Wolfpack Way
Kalispell, MT 59901

Re: Best Available Science and Forest Plan Response to Monitoring
Submitted via https://cara.ecosystem-management.org/Public//CommentInput?Project=46286

Dear Folks;

The 2012 Planning Rules require that you “Identify what information was determined to the best available scientific information, explain the basis for that determination, and explain how the information was applied to the issues considered.” (36 CFR 219.3) Like the preceding 1982 Planning Rules, the 2012 Planning Rules require an orderly revision of Forest Plans that is consistent with the results of monitoring that “is continuous and provides feedback for the planning cycle by testing relevant assumptions, tracking relevant conditions over time, and measuring management effectiveness.” (36 CFR 219.5(a)(3)). The current Flathead Forest Plan, on page V-19, similarly finds that revision should be based on “the monitoring and evaluation process.”

Amendment 19 and Best Available Science

The April 2014 Assessment of the Flathead National Forest and the DEISs fail to provide for a revised Forest Plan that is consistent with the results of monitoring. The Assessment, for example, notes on page 168-170 that Amendment 19 is far from being fully implemented to provide the requisite levels of grizzly bear habitat security, yet the DEISs do not include a single action alternative that would complete the job.

Instead, the Assessment and the DEISs essentially claim that, because there is new grizzly bear population data available, there is no need to complete the job and that the science used to develop A19 can essentially be ignored. This is clearly illustrated, for example, by the DEIS claims that there is no science indicating bears are displaced by non-motorized uses of trails and that old-school methods of calculating road densities can be applied as the best available science in the Salish and other DCAs rather than the more precise “moving window” GIS methods adopted by A19 and the IGBC.

Please find attached to this letter a 1994 Report from Kate Kendall to the IGBC as Chair of its Research Committee. It demonstrates that the question of whether non-motorized
use of trails displaces grizzly bears has been asked and answered with an emphatic YES. Yet this and other research that went into developing A19 and companion IGBC recommendations is essentially ignored by the Assessment and DEISs.

Similarly, the DEISs resort to the use of Boulanger and Stenhouse (2014) in order to justify allowing higher road densities to persist in the Salish and other DCAs, Zone 1 and Zone 2. The linear road densities used by Boulanger and Stenhouse in Canada have long been replaced by the more precise “moving window” GIS process as the best available science in the NCDE. Moreover, it is the latter process that was adopted by the IGBC and the Flathead in its A19 for grizzly bear habitat - which replaced the old linear road density models and continues to be used in biological assessments and biological opinions. Moreover, the DEISs cherry-pick Boulanger and Stenhouse and fail to report the study’s inclusion of male bears and the report’s finding that more restrictive road densities are necessary to reduce mortality to females with dependent offspring.

The upshot here is that the Assessment and DEISs should be responding to the Forest finding that A19 has not been fully implemented and bears not provided the promised levels of security - by proposing Plan alternatives that would do so. Instead, they are abandoning the best available science and attempting to abandon continued implementation of A19 altogether. Besides the attached Kendall report, we have provided and cited to abundant research and documents in our other comment letters that help explain how A19 and the IGBC approach was based in the best available science and came to limit non-motorized use alongside motorized use.

We ask that the whole of the A19 and IGBC Access Task Force administrative records be included in the Forest Planning records, along with all project-level and program-level biological assessments and biological opinions that have been issued relative to the implementation of A19. Per the 2012 Planning Rules, please identify which of that information you identify as the best available science, which you do not, explain the basis for that determination, and explain how that information is applied to the issues being considered.

This is more than an academic exercise and has real-world implications. By comparing map Figures 1-37 through 1-42, for example, it appears that grizzly bear Security Core is greatly increased in Alt. B in such areas as the Jewel Basin Hiking Area and the Bob Marshall Wilderness. This is a figment, however, of no longer buffering or disqualifying habitat as Security Core within 500 meters of high-use non-motorized trails. It does not reflect any change in management of those trails or their use levels. It flies in the face of the best available science and falsely makes A19 (Alt. A) appear worse for Security Core in these areas than the action alternatives. There’s nothing like lowering the goal posts to make one’s performance look better - except it is not allowed under the NFMA and NEPA requirements for scientific integrity.

Further Problems with A19 TMRD and Security Core

A similar case can be made for misrepresenting Total Motorized Route Density by not including roads in TMRD that have not been fully reclaimed and decommissioned. In that case, the DEIS openly admits it changed up the 1995 Alt. A No Action method for
calculating TMRD in 2013, when it began work on Forest Plan revision, rather than develop an action alternative that would do so. (See our 9/12/16 letter in this regard).

The Flathead is also trying to redefine the No Action Alternative to renege on past promises by omitting requirements for re-vegetation of reclaimed roads in order to “store” them instead of “decommissioning” them, rather than proposing action alternatives that would do so. If monitoring 20 years of implementing A19 indicates it may take more than a decade to adequately re-vegetate a reclaimed road so it no longer functions as a road or trail - and that this requires that Security Core remain in place longer than the A19 minimum of 10 years - then NEPA and the Planning Rules require that this be addressed through planning that is consistent with the results of monitoring and the best available science. As discussed in our 9/8/16 and 9/12/16 letters, the Flathead is instead attempting to sweep the problem under the rug by reinterpreting A19 in an unlawful manner, as though it can simply treat the first 200’ of reclaimed roads, ignore the remainder, and still not count them in TMRD or buffer them out of Security Core.

While Alt. C appears to reflect the reductions made in the suitable timber base in the 2006 draft revised Forest Plan, it is not clear to what degree those reductions were intended to make some Security Core permanent or longer-term than the 10-year minimum. Given the inadequacies in the Flathead’s road maintenance budget, the need to reclaim and decommission another 518 miles of road, and the fact that Alt. C’s reduced emphasis on timber production reduces the timber budget by $2.2 million, perhaps Alt. C and others should be refined to finish implementing A19 in a way that makes Security Core permanent. This certainly is more consistent with the best available science and monitored outcomes of the current Forest Plan than the attempts to abandon A19 entirely and bump the suitable timber base back up to require greater taxpayer subsidies for money-losing timber production.

Krause Basin

The DEISs similarly fail to treat Krause Basin in a manner that is consistent with the results of monitoring, promises made in the 1988 Noisy Face Recreation Plan, and promises subsequently made in A19. We appreciate that Alt. C would apparently honor the 1988 Spring and Fall area closure to motorized vehicles and supplement it with summertime closure of the old ATV trail system to motorized uses as well. The DEISs, however, make it appear that Alt. C somehow goes above and beyond the call of duty when all action alternatives should in fact do this in Krause Basin.

It is entirely out of step with the results of past promises and monitoring to designate Krause Basin a Focused Recreation Area with marked ATV trails, when the 1988 Plan said the trails were never to be marked on the ground and A19 requires further reductions in Total Motorized Route Density (TMRD)! Monitoring shows that ATVs continue to thwart the law and go wherever they please on both public and private lands in Krause Basin. This can only be remedied by making it clear Krause Basin is not a destination ATV area in a way that also finishes implementing A19.
We’ve attached an 8/27/16 Daily Inter Lake “Law Enforcement Roundup” concerning an ATV operating without permission on well-marked private property off Peters Ridge Road, with the result of the ATV operator getting pepper sprayed. Marking the old ATV trail system in Krause Basin will do nothing to reign in such abuse, which is why the majority landowners in the area were among the 98 people signing our petition to close the ATV trail system to motorized vehicles. The Krause Basin area closure has been well signed for decades and unlawful ATV use continues. Only by making it well known that Krause Basin is wholly closed to ATVs can citizens and the agencies begin to make strides in law enforcement. (See also our 8/15/16 letter in this regard).

Notes on Other Science

Dr. John Weaver -

We find that Dr. John Weaver on 9/12/16 issued further recommendations in response to the Flathead DEIS on behalf of the Wildlife Conservation Society. Unfortunately, his recommendations are the result of yet another reprioritizing of areas the Flathead still refuses to recommend for Wilderness in Alt. B, resulting in his recommending less Wilderness and less road decommissioning than his 2014 report - though apparently based on the same 2014 scoring/ranking of areas important to bull trout, westslope cutthroat trout, grizzly bear, wolverine, and mountain goat.

Recognizing “that the Forest Service is charged with managing for a diverse portfolio of values and land uses,” Dr. Weaver reduces his recommendations for Wilderness from 404,208 acres in 2014 to 261,748 acres in 2016, a reduction of about one-third (35%). This Dr. Weaver notes is “52% of the suitable area for Wilderness,” though he is actually referencing Alt. C’s 506,900 acres of recommended Wilderness.

We note that, according to the Flathead’s 9/2/16 response to our email inquiry, Alt. C recommends 98% (467,461) of Inventoried Roadless Areas for Wilderness and only 39,458 acres of the 177,438 non-IRA but “wilderness-suitable” acres (22%) for Wilderness. Using the true “suitable area for Wilderness” yardstick represented by the Flathead’s Final Wilderness Suitability Inventory of 644,899 acres suitable, Dr. Weaver’s recommendations for Wilderness represent 41% of the wilderness-suitable acres.

We respectfully disagree with Dr. Weaver and find that Alt. C represents a better conservation legacy for the Flathead than a slightly improved Alt. B. We further find that Alt. C falls short of our Citizen reVision alternative by not including more non-IRA wildland recovery areas, many of which are found by the Flathead to be wilderness-suitable, and by not carrying forward the continued and more widespread implementation of A19. We ask the Flathead to carefully distinguish between the best available science Dr. Weaver may have incorporated into his recommendations and the degree to which political considerations have influenced his recommendations - and to also consider the best available science for the wide array of wildlife species not included in Dr. Weaver’s analysis.
The IGBC’s Once-Proposed Rule Set to Replace A19 -

The IGBC in the latter 1990s appointed a group of interagency personnel and wildlife biologists to develop an alternative Rule Set to replace the A19 approach in order to have fewer impacts on human access to grizzly bear habitat. The group on 10/14/98 issued a manuscript as a companion to its “Draft - Rationale and choices made in the review and development of an access direction proposal for the NCDE Grizzly Bear Ecosystem, October 1998.” This manuscript openly admitted the ways it departed from the best available science, in part as follows:

We describe . . . standards that deviated from those suggested by an objective application of research findings . . . The authors of this paper were charged by this committee with the task of formulating a detailed proposal for managing public and agency motorized use, by integrating scientific data with the mandates of each agency . . . We acknowledge that our departure from the ‘strictly biological’ world and acceptance of this delegated authority was unorthodox . . . Implementing [A19’s 19/19/68 rule] required substantial reclamation of the existing road system . . . we desired that security areas be moveable by season . . . with roads opened and closed at specific time during the year . . . [our approach] depends on the effectiveness of non-permanent closure devices (e.g., gates) to preclude access when it is prohibited.

The group attempted to do this while simultaneously acknowledging that research found “even low-use roads had significantly negative coefficients in RSF analyses (Mace et al., in press), suggesting that security may be compromised by the mere presence of roads or non-motorized activities, if at high enough densities.” Not surprisingly, and as detailed in our 9/8/16 letter and its attachments, independent peer review of the proposed Rule Set gave it a thumbs-down and found:

The simplicity of A19 and its ability to permanently secure areas for grizzly bears makes it a powerful tool in the conservation of the grizzly bear in the NCDE . . . The proposed approach’s added complexity unfortunately necessitated several additional assumptions, some of which are tenuous . . . we caution against any relaxation of establishing permanently secure areas . . .

The above peer review by McLellan et al is included on the DVD we provided with our 9/8/16 letter and at http://www.swanview.org/reports/12_McClellan_et_al_2000_A19.pdf . The proposed Rule Set and “Rational and choices” documents are among those IGBC documents we ask earlier in this letter be included in the administrative record.

Simply put, the proposed Rule Set was abandoned for good reason and for its lack of scientific integrity - and A19 continues as the best application of the best available science. Now, however, the DEISs and proposed Forest Plan are attempting to once again cheat on grizzly bear security and TMRD by misrepresenting A19 requirements. As though all this debate over A19 and the science did not occur back in the 1990s and the agencies can now return to largely using gates and berms instead of thorough road reclamation and decommissioning.
Mike Bader’s Review of Pertinent NCDE Bear Data and Population Estimates -

We have attached Mike Bader’s “Review of Grizzly Bear Data and Population Estimates for the Northern Continental Divide Ecosystem,” which raises serious doubts about assumptions and methods that have been used to estimate the NCDE population and its population trend. We ask that you look into it and take seriously his findings that “it is premature to use the estimations for total population size and annual sustainable mortality as a basis for removing Endangered Species Act protections, reinstitution of hunting or for land management planning including the Flathead and Lolo National Forest Plan Revisions and the Four National Forest Plan Amendments for Grizzly Bear Habitat Management in the NCDE.

We ask that you take these doubts seriously because mistakes in population trends have occurred before, when agencies got the answer they were looking for and hence did not bother to double check their calculations. When Mace and Waller published their 1997 Final South Fork Grizzly Bear Study report and found a stable to increasing population, we had Dr. Lee Metzgar look it over. He found an error right away and alerted the authors, who then issued an errata sheet (attached) concluding:

An error in calculating the reproductive rate for 6 female grizzly bears was discovered . . . The actual reproductive rate for female cubs was 0.261 not 0.389. This change in reproductive rate served to change the mean estimate of lambda from 1.009 down to 0.977.”

In other words, the South Fork/Swan Mountain bear population was found to be declining by 2.3% per year, enough to halve the population in 30 years. It was not in fact found to be steady or increasing at 0.1% per year.

Summary

None of the action alternatives are consistent with the best available science, the results of monitoring of current Forest Plan implementation, and the continued implementation of promises made previously. Conversely, the No Action Alt. A, which would continue implementation of A19 (if it were correctly defined in Alt. A), does not propose updated actions warranted by monitoring (such as making Security Core permanent to reduce road maintenance and the need for roads, recommending more Wilderness to improved wildlife connectivity and to respond to national attitudes and expectations about Wilderness, and completing the phase-out of ATV use in Krause Basin).

Instead, all action alternatives jump off a cliff without the safety net of continued ESA protection of grizzly bears. While they promise to maintain habitat conditions present in 2011, they instead redefine habitat security so that less security will actually be maintained and to make more security appear where there will actually be less. Moreover, the DEISs and proposed Plan fail entirely to describe how 2011 habitat conditions will be maintained in the face of climate change that has already increased temperatures to new records in the area.
The DEISs essentially describe implementation of the No Action Alt. A as contributing to grizzly bear recovery, then set about trashing it by falsely describing various aspects of A19 and by wholesale abandonment of A19 in the action alternatives. The action alternatives all represent risky, uncharted territory not based in the best available science and instead based in bureaucratic slight of hand. None of the alternatives represent the requisite Plan revision based on a rational response to the conditions found through Plan monitoring and evaluation.

Thank you for this opportunity to comment.

Sincerely,

Keith J. Hammer
Chair

Attachments:

1. 1994 Kendall report to the IGBC
2. 8/27/16 Daily Inter Lake re Krause Basin ATV trespass
3. Bader Review of NCDE population estimates
4. Errata sheet to Mace and Waller 1997
July 18, 1994

Memorandum

To: IGBC members

From: Chair, Research Subcommittee K.C. Kendall

Subject: Effects of trail use on grizzly bear habitat use

At the March 20, 1994 IGBC meeting in Anchorage, Alaska, Tom Puchlerz gave a presentation on the task group report on access management. The group asked for guidance on whether to just address roads or expand coverage to include trails. The meeting participants concluded that there was insufficient information on the effects of trail use on grizzly bear habitat utilization on which to base trail access management. Through Tom, you have asked the Research Subcommittee to prepare a problem description with recommendations on how to proceed. Attached is our problem analysis on the effects of non-motorized human activity on grizzly bears.
EFFECTS OF NON-MOTORIZED HUMAN ACTIVITY ON GRIZZLY BEARS

Problem statement and analysis
IGBC Research Subcommittee
July 18, 1994

Background:

Research conducted on the impacts of highways, roads, and industrial and recreational development on grizzly bear habitat use patterns and mortality levels has provided a basis for road access management to protect grizzly bear populations. Although less information is available on the effects of non-motorized recreation, it has been clearly demonstrated that even low levels of human use can disturb and displace grizzly bears. On the Rocky Mountain Front, bears tended to use areas near low and moderate use trails more than areas near heavily used trails. Grizzly bears in the South Fork of the Flathead avoid trails and backcountry campsites. Gunther found that the number of bears sighted per day was inversely related to the number of people using an area and that fewer bears were observed near campsites when they were occupied by people than when vacant. Bear fishing activity on Yellowstone Lake spawning streams was at its lowest levels when angler numbers peaked in years of highest spawning runs. After those areas were closed to fishermen, bear use rose to the highest level in seven years of monitoring.

The predictability and intensity of disturbance influence the degree and duration of the displacement. In an experimental study, a hiker approaching grizzly bears in the backcountry or erecting a camp nearby, caused immediate and rapid displacement of bears. These bears moved further and more often and used lower quality habitat than undisturbed bears for at least two days after the disturbance. Haroldson and Mattson predicted that Yellowstone bears were likely to be disturbed more than was indicated by this study because the backcountry received more sustained use than was simulated by the tests. Disturbance response is likely to be greater for non-habituated bears and those in open or productive habitats. People hiking more than 500m from primary and secondary roads elicited strong flight responses from bears while people walking on these roads produced a more moderate response. In evaluating displacement effects of human recreation development in Yellowstone, Mattson found that disruption of bear activity extended much further in the backcountry than from roads, presumably, because of the greater human densities and persistently high levels of human activity at night around developments. Other factors contributing to bear response to recreational activity are the bear’s dominance status, physiological state, and foraging strategy.

Grizzly bear survival is compromised by recreational activity, particularly, where people are allowed to carry firearms. In Alaska, 31% of all non-sport grizzly bear deaths were caused by hunters, most of whom claimed defense of life or
property. Sport fishermen and hikers were responsible for 8% of the non-hunting grizzly bear deaths. In Alberta from 1972-84, excluding legal hunter take, grizzly bear mortalities were tallied as follows: 60% by hunters in self-defense, 30% by hunters mistaking a grizzly bear for a black bear, and 10% were problem bears killed in recreation or tourist camps. Hunter activities are also a source of grizzly bear mortality in Montana and Wyoming.

As more people penetrate into grizzly bear habitat, more bears are killed or removed from the population as the number of bear/human conflicts rises. The correlation between increased visitor use and grizzly bear problems has been documented in many areas. Encounters are especially common when recreation occurs within or near prime bear habitat. Because superimposing high recreational activity on preferred grizzly bear habitat results in direct mortality and reduced habitat effectiveness, concern about expanding human use in productive bear habitat has been expressed for many locales.

Non-motorized use restrictions have been deployed in various locations to protect grizzly bears from human disturbance. Seasonal closure of various areas instituted in Glacier and Yellowstone National Parks in the early 1980's, protect bears frequenting favored feeding sites. The Salish-Kootenai Tribe closed McDonald Peak to climbers in the late summer to ensure that human use did not preclude grizzly bears from feeding on army cutworm moths. It is clear that bears use the areas closed to people but the effect of the closures has not been quantified.

Interpretation of the impact of human disturbance on grizzly bear activity patterns is hampered by the lack of quantitative information on human use levels. National parks record the number of people registering for backcountry camping permits and thus have tracked backcountry camper levels. Backcountry day use on 60 trails in Glacier NP totaled approximately 160,000 hikers June-August in 1988. Backcountry trail use was categorized in low to high use levels from data collected on 74 trails in Yellowstone NP in 1992. But with no periodic backcountry human use level monitoring, there is no information on the intensity, type, or temporal-geographic distribution of use trends. Comprehensive backcountry use information is not available for any of the areas where intensive grizzly bear research has been conducted.

Untapped Data

We believe additional insight on the effects of backcountry use could be extracted from existing data sets. Specifically, we recommend the following analyses:

1) Describe grizzly bear mortality in the NCDE and GYE in relation to all man-made landscape features including trails and campsites.

2) In areas where grizzly bears have been studied intensively with radio telemetry,
analyze data for evidence of trail/camp avoidance, as has been done for roads. Potential study areas include South Fork, Flathead (Mace), Greater Yellowstone (Knight), Blackfeet (Carney), Cabinet/Yaak (Kasewormal), and Rocky Mountain Front (Aune).

3) For the 15 areas in Yellowstone NP where human use has been restricted since the mid-1980’s, compare pre- and post-closure bear habitat use.

How to Proceed

We recommend the above analyses be completed and evaluated before new research is initiated. At the IGBC’s request, the Research Subcommittee could provide guidance on analytical approach and appropriate collaborators and provide technical review of the products. Decisions to be made include:

1) Who will take the lead for each topic?
2) Can these analyses be accomplished by existing staff and funds? If not, how will it be funded?

Even if new bear research is not immediately initiated, the Research Subcommittee sees a need for more data on backcountry human use levels. At a minimum, we recommend emphasis be placed on monitoring trends in trail and campsite use. This is seen as particularly important in the NCDE and GYE, where recreational use is relatively high and is increasing.

A decision to conduct further research on the effects of recreation on grizzly bears should be made in light of the above and the amount of data managers feel they need to support trail access management. For road access management issues, managers are asking for mortality risk associated with different categories and densities of roads. Such research is very difficult and intensive. In our opinion, it research to establish a link between trail use and grizzly bear mortality would be even more difficult than that with roads and would involve a large commitment of resources. Because of the host of confounding factors, even further refinement of our knowledge of the effects of recreation on habitat use will involve intensive research spanning 5-10 years. We estimate that such a study would cost $50-100K/yr, even if conducted in conjunction with an existing study which had collared bears.
Bat attack may have been overblown

The Flathead County Sheriff's deputies responded after a man on Silver Leaf Drive in Kalispell said he heard what sounded like a person hitting someone with a baseball bat and a man yelling, "Don't hit me with the bat."

Deputies noticed a small amount of blood on a man's shirt, but both parties claimed the incident was only verbal. Both parties were advised if law enforcement was called any more that day, they would go to jail.

A woman reported the windows of her vehicle were shot out on Mountain Drive in Hungry Horse.

Farm Lane. The animal appeared to look malnourished and covered in algae.

Pictures of the animal were sent to deputies and the horse was said to look thin. It was also reported that the pasture was "eaten down" and not adequate forage.

An intoxicated man was allegedly "getting into people's faces" on First Avenue East North, according to the Kalispell Police Department.

A woman was allegedly trying to sell a vehicle that didn't belong to her and was causing problems on Flathead Drive. The woman then reportedly tried to climb through a window and injured her knee in the process.

Police have received several reports of counterfeit $20 bills circulating.

A side mirror of a vehicle allegedly hit someone's daughter on the hip, leaving a large bruise on Two Mile Drive and Cooper Lane. The mirror popped out and when the teen picked it up and tried to approach it, the vehicle drove away.

A woman on Third Avenue East North was heard yelling profanities at children.

Someone said two teens were allegedly riding his or her grandson's trike on Northwest Lane.

Someone on Ninth Avenue East North said a large TV was donated to a nearby church and three men were allegedly taking it.

Officers located the men and advised them to return the TV and talk with the church later.

A man allegedly...
Executive Summary

Population estimates for grizzly bear in the Northern Continental Divide Ecosystem (NCDE) in northwest Montana (N = 765 in 2004; N = 960 in 2014) are based on findings that grizzly bears have recently come through a period of population growth leading to range expansion at the rate of 2000km² annually.

Some believe the Primary Conservation Area (formerly known as the Recovery Area) may be approaching carrying capacity (K) and is producing dispersing bears that are exploiting new territory.

I discuss that given several mitigating factors, the N = 960 estimate may be overoptimistic, and should be supplemented by additional analysis. Research is required to better understand distribution and trends in mortality; habitat use in response to disturbance; the effects of human access on mortality and habitat security; source-sink habitat relationships; annual and long-term trends in climate and precipitation.

I argue that in the absence of this necessary information, it is premature to use the estimations for total population size and annual sustainable mortality as a basis for removing Endangered Species Act protections, reinstitution of hunting or for land management planning including the Flathead and Lolo National Forest Plan Revisions and the Four National Forest Plan Amendments for Grizzly Bear Habitat Management in the NCDE.
Introduction

Human population growth, drought, climate change and rapidly changing landscapes are a challenge to grizzly bears in the Northern Continental Divide Ecosystem (NCDE). Recent population estimates have projected sustained population growth. The State of Montana is now considering whether to administer a hunting program for grizzly bear if and when Endangered Species Act protections are removed. Costello, et al. (2016) evaluate data from 2004-2014 and use multivariate statistical modeling to estimate vital rates. They conclude the NCDE grizzly bear population now numbers \( \approx 960 \).

In order to put their findings in context, it is important to gain an understanding of what the state of the population was in 2004 and what has happened since.

Background

Mattson, et al. (1995) estimated the NCDE population at \( \approx 453 \) (mid-point of two mean estimates using data from Montana FWP and assuming 22.8% adult females and 60% sight-ability).

Kendall, et al. (2008), in a first-of-its-kind study using hair traps and DNA analysis, estimated a total census of \( N = 240 \) within their 7,933km\(^2\) study area and mean density of \( \approx 30/1000km^2 \).

Kendall, et al. (2009) estimated \( N = 765 \) across a total distribution area of 33,480km\(^2\).
Mace, et al. (2012) estimated that between 2004-2009, annual growth rate was 3.0%. Costello, et al. (2016) estimate N = 960 over 55,200km² (Figure 3) and annual growth rate of 2.3%.

Methods and Assumptions

The use of the models and equations in Costello, et al. are not questioned. Of more interest are the values and assumptions that went in and the final results that came out.

Costello, et al. use methods included in previous studies. These include using data sets from the most productive and secure areas in the NCDE, with presumably higher annual survival rates. Not only did they focus trapping where densities were highest, at page 35 they show mortalities by management unit. Their study area had the least and second least, respectively, mortality as a percent of total NCDE mortalities. Mace & Roberts (2011) also noted they had a trap bias because they focused their efforts in areas with high bear density.

Costello, et al. make some assumptions that could bias their results. In looking at mortality they assessed the period during their study 2004-2014, which is a period when annual mortality was in decline.

In another example, the maximum age of senescence in adult females (the end of reproductive ability) is set at 28 years when their oldest observed female with a litter of cubs-of-the-year was 26 and there was no indication the cubs survived to adulthood. In fact, very few female grizzly bears even live to age 25, let alone successfully defend and raise cubs. Schwartz, et al. (2003) found rapid senescence after age 25 is not that important because few individuals survive that long. Of Schwartz, et al.’s sample size (n = 4,726) ≈ 10% were age ≥ 20 and only 2.1% were ≥ 25 years. They found “Our results conform to senescence theory and suggest that female age structure in brown bear populations is considerably younger than would be expected in the absence of modern man.”

Doak & Cutler (2014) detected a similar issue with modeling of grizzly bear vital rates in the Yellowstone ecosystem where studies assumed no reproductive or survival senescence occurred until age 30. One bear out of a sample of thousands can be considered a statistical outlier rather than being a model parameter.

Mace, et al. (2012: 126) wrote: “Our oldest known-aged female was 27 years old and produced cubs the previous year. In our estimate of population trend, we assumed all females died after age 27, although females are known to live longer (Schwartz et al. 2003). We do not believe that omitting these older females influenced our estimate of population trend, as very few individuals this old would be present in the population.” Then why did Costello, et al. set senescence at 28?
Costello, et al. (2016:61) observed a higher proportion of females at older age classes. It must be kept in mind their study area was located within some of the highest productivity and most secure habitat, with presumably higher annual survival rates, so older females might make sense within that constrained area, but cannot be extrapolated across the NCDE.

Other estimated values trended towards being higher than the observed values. For example, the annual survival rate for males based on observed values was 80.5-91.6 while the estimated value was 89.5, well above the mean.

Another issue of concern is estimation of unreported mortality. Underestimated values could affect annual survival rates. Costello, et al. also assumed a “high rate” of self-reporting for mistaken identity kills.

On page 75 they state that underestimated unreported mortality leads to a higher survival rate for males, potentially skewing the probabilities of increase or decline. In fact, in discussing their estimates for annual sustainable mortality they write at page 85: “direct application of these numbers as mortality thresholds requires additional evaluation.”

Another potential bias is the practice of not counting any mortality that occurs > 16km (10mi) from the Primary Conservation Area (PCA). Presumably, the majority of these bears are dispersers who were born within the PCA, and thus were counted towards natality but then later are not counted towards mortality. There were two such bears in both 2013 and 2014. At page 90 Costello, et al. conclude “≈ 10-28 additional mortalities would likely be sustainable.”

**Mortality**

Major studies in the NCDE have documented negative population growth and excessive annual mortality amongst females. Mace & Waller (1997) documented a negative annual growth rate of -2.3% in their demographic study of bears in the Swan Mountains and S. Fork Flathead River. Given that Costello, et al. report 34% of all NCDE mortalities 2004-2014 occurred in this area gives little confidence that the trend has reversed.

Kendall, et al. (2009) expressed concern that in their study area annual mortality was 4.6%, above the 4% threshold for annual sustainable mortality, and they found “the high proportion of female mortalities raises concern.”

**Post-Hunting Mortality Shift**

Bader (2000a) found that during hunting seasons in the NCDE, the wilderness/non-wilderness ratio was 1:1.2. Following the end of hunting it was 1:4.5. Since that time that trend has strengthened. From 2004-2014 there were just a handful of mortalities within the wilderness habitats of Glacier National Park (GNP, n = 3) and the Bob Marshall Wilderness (Figure 4).

Costello, et al. at page 31 showed that mortalities outside the PCA were 18% of the total in 2004 and more than doubled to 44% in 2014. Over that same time period they estimated that mortalities in the NCDE increased at the rate of 2-3%/year.

Bader (2000a) also found that following the end of hunting, the mortalities/year declined in both the NCDE (from 19.1 to 13.0) and the Yellowstone ecosystem, suggesting that hunting represents additive rather than compensatory mortality. If the population has really grown from N = 453 to N = 960 during the post-hunting period, it provides some evidence that hunting in the NCDE suppressed population growth.

The response of bears to hunting was not well understood. Presumably, they used the security of mountainous wilderness. One male was known to make a beeline for the Sun River Game Preserve each fall just prior to hunting season.

If hunting is resumed, pressure may initially target bears on the periphery. The bears at the edge of the range may play an important role in exploring and adapting to new habitats and food resources. If the population continues to run into a wall of mortality at the edge of the distribution area, then new adaptations are not available to be passed on through the population.
Habitat Security

Costello, et al. (2016) did not assess habitat security in relation to mortality risk or habitat selection. Their “Proposed Monitoring and Reporting Protocols” (p. 111-113) are limited to demographic numbers within the DMA and make no recommendations for habitat security monitoring or evaluation of source-sink relationships.

Increased habitat protection measures and standards should be applied throughout the DMA (the PCA, Zone 1 and the linkage areas to the Cabinet-Yaak, Bitterroot and Yellowstone ecosystems). This should include the Amendment 19 habitat management plan on the Flathead National Forest. An exception is that secure “core” area should not shift over time. Under the current strategy, by the time a bear learns an area is secure, a new project comes in and the bear must move to another area, most likely already occupied. Or, it can stay and face increased mortality risk.

In Zone 1, management should focus on increasing the potential for residential occupancy by female/cub groups through increased habitat security.

Linkages should address and support both demographic and migratory functions. Linking “demographic stepping stones” of secure, roadless areas ≥28.3 km² (7,000 acres) (Mattson 1993) with low road density areas could support female/cub groups. These need to be spatially located within estimated dispersal movements for female grizzly bears.

The idea is to grow isolated populations together, as opposed to maintaining movement “highways.” Linkages with low security are mortality sinks and will not provide genetic rescue effects or expansion of habitat area continuously occupied by female/cub groups.

Habitat Productivity, Past and Future Disturbances

In looking at habitat productivity using annual precipitation as a proxy, Bader (2000c) found that 46% of the PCA receives < 102 cm of annual precipitation (≈ 50 inches), most of which falls as snow (Figure 6). The areas with the highest reported grizzly bear densities correspond with areas having ≥ 127 cm of annual precipitation. These areas comprised ≈ 36% of the PCA. Considering the period of drought, these proportions may have shifted.

When looking at the total reported distribution area of 55,200 km², the high productivity areas shrink as a percentage of the total area. Bader (2000c) and Mowat, et al. (2013:8) found that grizzly bears do not and...
will not likely exist in meaningful densities in areas with < 50cm (20in) annual precipitation.

Moreover, the NCDE area has experienced a prolonged drought over the past ten years and remains so in 2016 (www.droughtmt.gov).

Based on stable isotope analysis, bears in the NCDE have two basic economies (Figure 5). In the mesic northwest, huckleberries are a major resource and home ranges are smaller and density higher. In the xeric east, bears have high meat protein, primarily from livestock carrion, and home ranges are much larger and densities lower.

McClellan (2015) found that a period of poor huckleberry crops coincided with a significant period of population decline in the North Fork Flathead, B.C.

Simonin (2000) found that big huckleberry is adapted to sprouting after fire from deep and shallow rhizomes and root crowns and is also efficient at storing nutrients released during burning. It will generally survive low to moderately severe fire, attaining pre-fire coverage within 3-7 years, with increases in stem numbers and density.

On the other hand, high severity burns may cause moderate to high mortality. After strong decreases, recovery may take 15-20 years or more and oftentimes does not achieve pre-fire levels.

Figure 5. Northwest and East Front Grizzly Bear Food Economies in the NCDE. Courtesy Dr. David J. Mattson.

Figure 6a. and b. Annual Precipitation in the NCDE Top: 1961-1990; bottom 1981-2010. Dark blue colors = mesic areas (≈ 100-175cm/yr.); light blue, green, yellow & brown = xeric areas (≈ 20-50cm/yr.) Source: PRISM Climate Group. Oregon St. University.
However, fire exclusion also has deleterious effects on big huckleberry production. Simonin (2000) cited Miller (1978) who found a 3237ha (8000 acre) huckleberry field in Washington had diminished to 1011ha (2,500 acres) following 40 years of fire exclusion, as much of the field was replaced by trees and brush. Zager, et al. (1980) found similar effects within the NCDE. Thus, exclusion of wildfire can have long-term negative effects on production of key food resources. Low severity fires can have positive effects after about 5 years. Conversely, moderate to severe intensity wildfires can have both long and short-term effects, depending on the location and severity of the fire and its spatial relationship to other similar events.

Post-fire recovery of shrub and berry fields is slower and less effective in dry areas with rocky soils (Simonin 2000). Prolonged drought conditions are more likely to support moderate to severe intensity wildfires over larger areas. Harvey, et al. (2016) found that from 1984 to 2010, the percentage of severe, stand-replacing fire within fire perimeters in the northern Rockies increased from 22% to 27%. Stand-replacing fires burned ≈ 5% of the total forested area, with most of the stand-replacing fire occurring in patches larger than 100ha (75%) and 1000ha (50%), respectively. They concluded “If trends continue on the current trajectory...fires may produce larger and simpler shaped patches of stand-replacing fire with more burned area far from seed sources.”

There have been several large-scale fires in the NCDE over the past 30 years (Harvey, et al. (2016). What effects these have had on bear distribution, densities and trends is not known. However, it makes intuitive sense that if a large area of a bear’s home range is temporarily unavailable as a foraging area due to disturbance from either fire or human development and use, it will have to move to another area that may already be home to a bear(s), increasing stress and potential conflict within the population. In the context of source-sink dynamics, pockets of high density may not necessarily be a sign of population growth but rather a result of temporary “crammage” or a bleeding of bears from source habitats into sink areas. This effect is noticeable in the Swan Mountains, a narrow area of roadless habitat separated from the Great Bear Wilderness by an extensive network of logging roads, clearcuts and the Hungry Horse Reservoir. Bears in this area may never have recovered from the direct habitat loss caused by the reservoir and the logging and roadbuilding activity. This landscape still lacks adequate security for the population to rebound.
Grizzly Bear Density

Kendall, et al. (2008) estimated that grizzly bear densities inside Glacier National Park (GNP) were ≈ twice those outside the Park within their study area (Figure 7). At a 2:1 ratio of inside vs. outside, approximate densities would be 39/1000km² inside the Park, and 20.1/1000km² outside. These figures are important for comparison of densities in other portions of the NCDE.

Kendall, et al. (2009) estimated N = 765 across a total distribution area of 33,480km², which results in a total mean density for the NCDE of 22.8/1000km². Separating the 7933km² and N = 240 from Kendall, et al. (2008) yields a mean density of 20.6/1000km² for the ≈ 76% of the NCDE distribution area south of Glacier National Park.

Naturally, bears do not occur in a uniform density across large landscapes. In discussing total distribution Bader (2000b:327) observed: “This broader boundary provides no information on the density, population trend or health of the populations within, and it encompasses areas that may be occupied sporadically, at low frequency and at low densities.”

As such, to support a mean density of 20.6/1000km² over this vast area, certain areas would have to support densities approx. equal to those inside GNP (> 35/1000km²). However, previous estimates from the NCDE outside GNP have all reported densities ≤ 20/1000km² (Table 1).

Bears in the lower 2/3 of the NCDE, where conditions are more xeric, berries are far less of the diet and home ranges significantly larger than those in the upper 1/3, are unlikely to exist at the same densities as those immediately adjacent to Glacier National Park.

Mace, et al. (2012:122) calculated “percent relative population density” of radio-collared females from 2004-2009. They showed 38.5% in GNP...
and 31.5% in the areas adjacent to GNP (Blackfeet Reservation/Badger-Two Medicine; North Fork Flathead River; Middle Fork Flathead River-Great Bear Wilderness). Thus 70% of the relative population density of female grizzly bears was located in the northern 1/3 of the NCDE.

Bears adjacent to GNP also have the advantage of using portions of GNP on a seasonal basis, providing added productivity and security (Figure 9).

Conversely, the large area comprised by the Bob Marshall Wilderness, Rocky Mountain East Front and Scapegoat Wilderness (more than half of the PCA) had just 17.5% of the relative population density. The South End and the Swan Valley- Mission Mountains contributed just 3.3%.

Costello, et al. did not calculate mean density as per Kendall, et al. (2008). However, at pages 22-23 they explain how they calculated relative densities of male and female bears based on the

Table 1.

<table>
<thead>
<tr>
<th>Source</th>
<th>Area</th>
<th>n/1000km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Servheen</td>
<td>Mission</td>
<td>20.4</td>
</tr>
<tr>
<td>(1981)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aune, et al.</td>
<td>East Front</td>
<td>13.5-19.6</td>
</tr>
<tr>
<td>(1986)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mace &amp; Waller</td>
<td>South Fork</td>
<td>10.0-20.3</td>
</tr>
<tr>
<td>(1997)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kendall, et al.</td>
<td>Glacier</td>
<td>30.0</td>
</tr>
<tr>
<td>(2008)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 8. Grizzly Bear Density in the NCDE. From Kendall, et al. (2009).

Figure 9. Grizzly Bears Outside GNP With Home Ranges That Include Part of GNP. From Mace & Roberts (2011).
Kendall, et al. data from 2004 and displayed the results (Figure 10). They are consistent with Mace, et al. (2012). Densities of both female and male grizzly bears peak in the core of GNP and steadily wane going south. Densities in the core of GNP are many times those in other areas of the PCA.

Figure 10. Relative Female Grizzly Bear Density in 2004. From Costello, et al. (2016).

The total estimated NCDE distribution area has increased from 33,480km$^2$ (Kendall, et al. 2009) to 55,200km$^2$ (Costello, et al. 2016). Part of this increase is due to Costello, et al. considering grizzly bear observations between the Cabinet-Yaak Recovery Area and the PCA to be part of the NCDE population. Bader (2000b) found significant overlap between the population data sets for the two areas. Kasworm, et al. (2015:19) show Cabinet-Yaak observations up to the western boundary of the NCDE. Is the area between the two part of the Cabinet-Yaak distribution area, the NCDE, both or neither?

Another factor is Costello, et al. used different grid sizes for calculating relative population density (7km$^2$) and distribution (49km$^2$). Thus, large areas of low productivity habitats beyond riparian corridors and bone yards were included on farm and ranchlands with cattle, orchards, bee hives, chickens, etc. that are hostile habitat. In reality grizzly bear densities are probably < 2/1000km$^2$ in these areas.

If outlying observations and their geographic area are excluded, based on the grizzly bear literature, the remaining area is not likely to sustain densities that would support $N = 960$.

Costello, et al. at page 15 show that two Bear Management Units, the South Fork Sun/Beaver-Willow and Dearborn/Elk Creek, had occupancy by females with cubs, yearlings or two year olds just five, and six, respectively out of 10 years from 2004-2014. Another BMU, North Fork Flathead north of the Whitefish Mountain Resort, had occupancy just four out of the 10 years. Based on their reported data, on average 26% (6 of 23) of BMUs did not contain reproductive females annually. Mace & Roberts (2011) also mapped areas where females were not detected by telemetry (Figure 11), but non-detection may be due in part to the remoteness of the areas.

Moreover, if the population in the PCA is actually approaching K, theory suggests grizzly bears should show the effects of density-dependent population regulation including lower birth rates and higher incidence of intraspecific killing and cub mortality. McClellan (1994:15) wrote: “In reality however, human influences may rarely permit brown bear populations from attaining these levels.” The only possible exception in the NCDE is inside GNP, where hunting is not allowed and mortality is limited.

Costello, et al. did not find lower mean litter sizes or evidence of excessive cub mortality.

The Effective Distribution Area

Mortalities and observations increase with human density and viewing opportunity and are more a result of where the people are, thus biasing the distribution of observations towards the periphery of the PCA. Different parts of the NCDE have different sight-ability. For example, the South End has open, rolling terrain where a bear may be sight-able from long distances by different groups of people.

Using the data presented in Mace & Roberts (2011) and their map figure based on 2004 data from Kendall, et al. (2009)(Figure 12), I calculated an “effective distribution area.” Just as the effective population, $N_e$ is a fraction of the total population size, the effective distribution area $D_e$ the area where breeding occurs, cubs are being born and reared is some fraction of the total distribution area.
Summing the 10km² grids outside the PCA that were occupied by both males and females (Figure 12), there are \( \approx 71 \) grids accounting for \( \approx 710 \) km².

Added to the PCA area of 23,133km², \( D_e \) was \( \approx 23,843 \)km² in 2004 and was \( \approx 76\% \) of the total distribution area.

At \( N = 765 \), the mean density within the effective population area was \( \approx 32/1000\)km², even higher than the 30/1000km² reported by Kendall, et al. (2008). Given previous estimates which cluster in the range of 10-20/1000km², and the much drier southern and eastern portions of the NCDE, this is very unlikely.

There are limits to the grid method because one bear on a dispersing or seasonal movement can “light up” several cells, perhaps overstating the amount of overlap between males and females, whereas other occurrences are not detected. The data also represents total observations from 2004-2011, so variations between seasons are masked.

Mattson (1997) documented expanded home ranges during drought years while Mattson (1998) and Jonkel & Cowan (1971) found direct links between years of poor whitebark pine and huckleberry production, respectively, and elevated levels of bear mortality and management actions. \( K, N_e \) and \( D_e \) change from year to year within ecosystems. Narrow or peninsular reserves will create ‘crammage’ even in good food years, and elevate mortality risk and stress within bear populations in drought or poor food source years.

In the absence of increased habitat security, it has to be asked what portion of range expansion actually makes a positive contribution towards population recovery and viability?

Many of the forays far onto the plains (Figure 2) are by bears following riparian corridors, primarily in search of chokecherries. Once away from the mountains, they have opportunities to come into contact with grain bins and livestock.

One-way forays into high-risk habitats are a drain on the population rather than evidence of population growth.

Moreover, the Costello, et al. review of mortality reveals most of the mortalities at the edge or beyond the
PCA and DMA are young males. Why? Because the whole area within the PCA is full? Or because large areas within the PCA have been disturbed by natural and man-made events and what is left is full? The release of competition in the area beyond may be driving some of the range expansion.

The review of mortality distribution reveals that $D_e$ has certainly shrunk as a percentage of the total distribution area, which should provide cause for additional analysis.

It is important to calculate $D_e$ on an annual as well as cumulative basis (not every 1-5 years as recommended by Costello, et al.) to better understand movements in relation to annual seasonal as well as long-term changes in habitat, climate and habitat use.

**Conclusion**

Several aspects of the status of the grizzly bear population in the NCDE remain unknown and require further detailed evaluation.

The reasons behind recent expansions in the total distribution area are not yet well understood, and could be due to factors other than rapid, sustained population growth.

A question that must be answered is: was the condition of the grizzly bear population in 2004, (in the midst of a prolonged drought and in the wake of findings of negative population growth and excessive female mortality) really $N = 765$ and poised for ten years of population growth and range expansion at the rate of 2000km$^2$/year?

It would be remarkable if the population more than doubled between 1995-2014 (from 453 to 960) in the face of drier conditions and large-scale habitat disturbances, years with excessive mortality and other years where some BMUs did not have females with offspring, increased human population growth and visitation. As such, there are credible reasons for considering $N = 960$ as optimistic and I believe there may well be an equally compelling alternative narrative.

Additional research is required to better understand distribution and trends in mortality, habitat use in response to disturbance, the effects of human access on mortality and habitat security, source-sink habitat relationships and annual and long-term trends in climate and precipitation.

In order to expand $D_e$, the effective distribution area, increased habitat protection measures and standards must be applied to the PCA, Zone 1 and the linkage areas to the Cabinet-Yaak, Bitterroot and Yellowstone ecosystems. In Zone 1, management should focus on increasing the
potential for residential occupancy by female/cub groups through increased habitat security.

I argue that in the absence of additional necessary information and habitat security measures, it is premature to use the estimations for total population size and annual sustainable mortality as a basis for removing Endangered Species Act protections, reinstatement of hunting or for long-term land management planning including the Flathead and Lolo National Forest Plan Revisions and the Four National Forest Plan Amendments for Grizzly Bear Habitat Management in the NCDE.
Literature Cited


ERRATA, PAGE 112, MACE AND WALLER

An error in calculating the reproductive rate for 6 female grizzly bears was discovered upon publication of this manuscript. The actual reproductive rate for female cubs was 0.261 not 0.389. This change in reproductive rate served to change the mean estimate of lambda from 1.009 down to 0.977. The correct text and table for the section "vital rates and population trend" should read as follows:

Our estimated finite rate of increase (\( \lambda \)) was 0.977 (95% CI = 0.875 - 1.046) given the fixed and estimated demographic variables (Table 6). The uncertainty in \( \lambda \), as indicated by the proportion of the variance explained, was primarily due to variation in subadult female survival (56.07%) followed by adult female survival (37.25%). Cub and yearling survival explained a small proportion of the variance (Table 6).

The probability that the population was declining was 69%, stable to increasing 31%, and increasing 27%. The annual exponential rate of increase (\( r \)) was -0.02 (-0.13 - 0.045), indicating it would take \#30 years to observe a population halving, given long-term stability of vital rates.

Table 6. Estimated annual survival rates by class, reproductive rate, and population trend of grizzly bears in the Swan Mountains, Montana. 1987-1996.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Sample size</th>
<th>Estimate</th>
<th>Lower 95% CI</th>
<th>Upper 95% CI</th>
<th>SE of estimate</th>
<th>Variance proportion (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult female survival (S_A)</td>
<td>16/56*</td>
<td>0.899</td>
<td>0.785</td>
<td>0.966</td>
<td>0.046</td>
<td>37.25</td>
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<tr>
<td>Subadult female survival (S_S)</td>
<td>15/21*</td>
<td>0.825</td>
<td>0.639</td>
<td>0.962</td>
<td>0.089</td>
<td>58.07</td>
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<tr>
<td>Yearling survival (S_Y)</td>
<td>25/30*</td>
<td>0.908</td>
<td>0.906</td>
<td>1.000</td>
<td>0.049</td>
<td>1.53</td>
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<tr>
<td>Cub survival (S_C)</td>
<td>23</td>
<td>0.785</td>
<td>0.643</td>
<td>0.928</td>
<td>0.076</td>
<td>2.87</td>
</tr>
<tr>
<td>Age first parturition (a)</td>
<td>fixed</td>
<td>0.0</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Reproductive rate (m)</td>
<td>6</td>
<td>0.251</td>
<td>0.214</td>
<td>0.316</td>
<td>0.026</td>
<td>2.88</td>
</tr>
<tr>
<td>Maximum age (w)</td>
<td>fixed</td>
<td>25.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lambda (( \lambda ))</td>
<td>5000</td>
<td>0.977</td>
<td>0.875</td>
<td>1.046</td>
<td>0.043</td>
<td></td>
</tr>
</tbody>
</table>

* Survival rate estimates may differ from those in Table 4 as described in Methods.
* The proportion of variance in lambda explained by each parameter.
* Number bears/year-years.
* Reproductive rate is for female cubs only. Assumed sex ratio at birth of 50:50.